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Agricultural Production and Trade In French North Africa

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Since the Allied landing in French North Africa in November 1942, food production, surpluses, and deficits in French Morocco, Algeria, and Tunisia have become a matter of immediate concern to the United Nations. Before the war, French North Africa was a surplus-food-producing region. It had a substantial net export of food grains, wine, fruits and vegetables, and sheep and was about self-sufficient in oils and fats; sugar was the only important food which was entirely imported. During the war period, however, food exports dwindled to insignificance, and acute local shortages appeared. In the more recent years, the region has even had to import considerable quantities of grain. This striking change in the food position of French North Africa is bound up with the physical and human elements that condition the region's agriculture.

Physical Features of the Region

French North Africa includes the three countries of French Morocco, Algeria, and Tunisia, which, together with Spanish Morocco, occupy the upper northwestern portion of the African Continent (fig. 1). They have a combined area of some 1 million square miles, or one-third the area of continental United States. The bulk of the region, however, consists of deserts and mountains. Little more than 6 percent of all the land is cultivated, 12 percent is classified as rough pasture and grazing tracts, 2.5 percent is covered with forests, and another 2.5 percent with alfa grass, leaving over 75 percent as unproductive. (See table 1.)

The Atlas Mountains cut across upper French North Africa, running from southwestern Morocco to northeastern Tunisia. This mountain system is highest in Morocco, where three principal ranges are distinguished: The Great Atlas, which rises well over 10,000 feet south of Marrakech; the Anti-Atlas to the south; and the Middle Atlas to the north. In eastern Morocco and in Algeria, high plateaus (3,000 to 3,500 feet) are bordered by the Tell Atlas on the north and the Saharan Atlas on the south. In eastern Algeria and in Tunisia, these chains come together again and extend as far east as Cape Bon.

South of the Atlas Mountains stretches the Sahara Desert, where crop production is confined to the oases. Rainfall is also scanty on the high plateaus, and temperatures are extreme. Nearly all the cultivated land lies in the rather narrow coastal zone on the seaward sides of the Atlas, which is more or less exposed to the influences of the Mediterranean or the Atlantic. Here the climate is more moderate, becoming quite mild near the coast, and the mean annual rainfall in most parts exceeds 15 inches.

Morocco has over two-fifths of the cultivated land of French North Africa, concentrated chiefly in the western part of the country between the Great and Middle Atlas and the Atlantic. In western Morocco, the elevation increases in steps from the coastal lowlands and the valley of the Sebou to the mountains which bound the region on the south and east. Rainfall is ample in the north and on the seaward sides of the Great and Middle Atlas. On the plains farther south, however, desert influences become stronger. Below Casablanca, western Morocco receives an average of less than 15 inches of rain per annum.[1]

Algeria has somewhat less land under cultivation than Morocco. In the northern coastal zone, where most of the crops are grown, the mountain chains, separated by sometimes large valleys and plateaus, run parallel to and closely approach the sea. The high coastal mountains between Blida and Bizerte receive more rain than any other section of French North Africa (*2*, p. 46). They shelter the lower interior plateaus of Sétif and Constantine and much of Tunisia from the rain-bearing westerly and northwesterly winds. Similarly sheltered by the mountains of Spain and Morocco are western Algeria and eastern Morocco. In this section, the coastal hills are lower than such interior upland plateaus as Tlemcen and the Ouarsenis, but they act as a screen to the intermediate valleys, such as the great valley of the Chéliff.

In Tunisia, the smallest of the three countries, the Atlas system turns to the northeast, leaving a considerable stretch of lowland along much of the east coast. Rainfall is fairly abundant in nearly all of northern Tunisia, but south of Sousse it drops below an annual average of 15 inches, and at Sfax the mean amounts to little more than 8 inches.

*Office of Foreign Agricultural Relations.

[1] See rainfall map (*2*, p. 45); italic numbers in parentheses refer to Literature Cited, p. 105.

TABLE 1.—*Land utilization in French North Africa, average 1933–37*

Category	French Morocco [1]	Algeria	Tunisia	Total
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*
Wheat, durum	2,362	3,109	1,547	7,018
Wheat, common	850	1,040	324	2,214
Total wheat	3,212	4,149	1,871	9,232
Barley	4,159	3,180	1,149	8,488
Oats	79	457	71	607
Corn and sorghum	1,305	52	52	1,409
Other grains	59	5	[2]	64
Total grains	8,814	7,843	3,143	19,800
Broadbeans	146	79	60	285
Chickpeas	92	37	17	146
Other dry legumes	92	27	[2]	119
Total dry legumes	330	143	77	550
Forage crops	82	99	86	267
Other field crops	[3] 222	[4] 54	[5] 220	496
Total sown area	9,448	8,139	3,526	21,113
Fallow	7,791	[6] 6,234	[6] 3,598	17,623
Vines	[7] 57	991	121	1,169
Truck crops	44	91	[5] 20	155
Tree crops	383	[9] 475	867	1,725
Total cultivated area	17,723	15,930	8,132	41,785
Pastures and grazing tracts	[10] 19,363	[11] 50,744	[12] 8,525	78,632
Forests	6,300	[13] 8,962	2,510	17,772
Alfa	5,436	9,823	2,965	18,224
Unproductive [14]	49,679	459,362	8,756	517,797
Total area	98,501	544,821	30,888	674,210

[1] Some 148,000 acres cultivated in extreme south, not declared for purposes of the annual tax on production and not classified by crops, are here included under "other field crops."
[2] Not separately specified.
[3] Flaxseed (40,500 acres), coriander, cumin, and industrial crops, plus 148,000 acres cultivated but not shown by crops. (See footnote 1.)
[4] Tobacco (53,600 acres) and cotton.
[5] Not separately specified. Probably includes some truck crops. See footnote 8.
[6] Bare fallow and pasture fallow, mown or grazed.
[7] In regular vineyards.
[8] In Contrôle of Tunis and Caïdats of Soliman and Nabeul only, in late twenties.
[9] Only those enterprises with 20 or more trees per acre.
[10] Including land that could be reclaimed.
[11] 89,000 acres of permanent meadows and a maximum of 50,655,000 acres of rough pastures and grazing tracts, 75 percent of which are in the Southern Saharan Territories.
[12] Natural meadows and pastures (247,000 acres), grazing tracts, uncultivated productive land, and acreage under alfa.
[13] 1933.
[14] Difference between other categories and total area.

Compiled by the Office of Foreign Agricultural Relations from official sources and the INTERNATIONAL YEARBOOK OF AGRICULTURAL STATISTICS (*4*) and (*5*).

While the average yearly rainfall received varies widely in different parts of North Africa, its seasonal distribution everywhere shows the unevenness characteristic of the Mediterranean climate. Winter is the rainy season, and summers are dry. As is also common in Mediterranean countries, both the annual rainfall and its seasonal distribution are marked by great irregularity from year to year.

The disadvantages for agriculture of such an irregularly distributed and uncertain annual rainfall have been mitigated by irrigation in some areas. However, irrigation possibilities in French North Africa are restricted, compared to those in countries with large rivers. Most French North African streams are short and torrential. Not only do they contain little, if any, water in summer, but in dry years the flow is small even in winter. Irrigation works, frequently simple and crude, have long served to supplement rainfall in the winter season with water from streams, and the use of basins, cisterns, and wells to obtain a year-round water supply also dates from ancient times in parts of the region.[2] Under the French, large dams designed to regulate the seasonal and even the annual supply of irrigation water have been built on various rivers in Algeria and Morocco, and others are under construction or projected. How much of the land can be irrigated is at present not known, but it certainly constitutes only a small proportion of the total crop acreage.

Population

French North Africa has rapidly increasing population. The number of inhabitants rose from 13 million in 1926 to 16 million in 1936 and probably amounts to over 20 million at present. The region is largely peopled by Moslems of Arab and Berber descent. According to the census of 1936, about nine-tenths of the inhabitants enumerated were Moslems. The remaining tenth included some 1 million Frenchmen; over 300,000 Jews; 130,000 Italians, mostly in Tunisia; 115,000 Spaniards, mostly in Algeria; and less than 50,000 persons of other nationalities.

A vast majority of the people live in the coastal zone. Some idea of the distribution of population is conveyed by the fact that northern Algeria;[3] Tunisia, excluding the military territories; and French Morocco, excluding the territories of Dra and Tafilalet and the region of Oujda, which account for about 20 percent of the total area of French North Africa, had 92 percent of the inhabitants in 1936. Even in this 20 percent of French North Africa, however, the number of persons per square mile, which averaged 71 in 1936, was considerably smaller than in the Mediterranean countries of Europe.

Agriculture is by far the leading occupation of the Moslems but employs a rather small proportion of the European population. Some of the Moslems, like the Europeans, are settled farmers, especially those engaged in horticulture, which has been raised to high technical levels in such sections as Kabylia and the high valleys of the Great Atlas. Others are nomads who travel with their flocks in search of feed. Perhaps the greater number lead a seminomadic life, combining a primitive type of arable farming with migratory livestock raising. In general, the importance of nomadism

[2] For a description of some of these works in Algeria, see (*8*, pp. 34–35).
[3] That is, the Departments of Oran, Algiers, and Constantine.

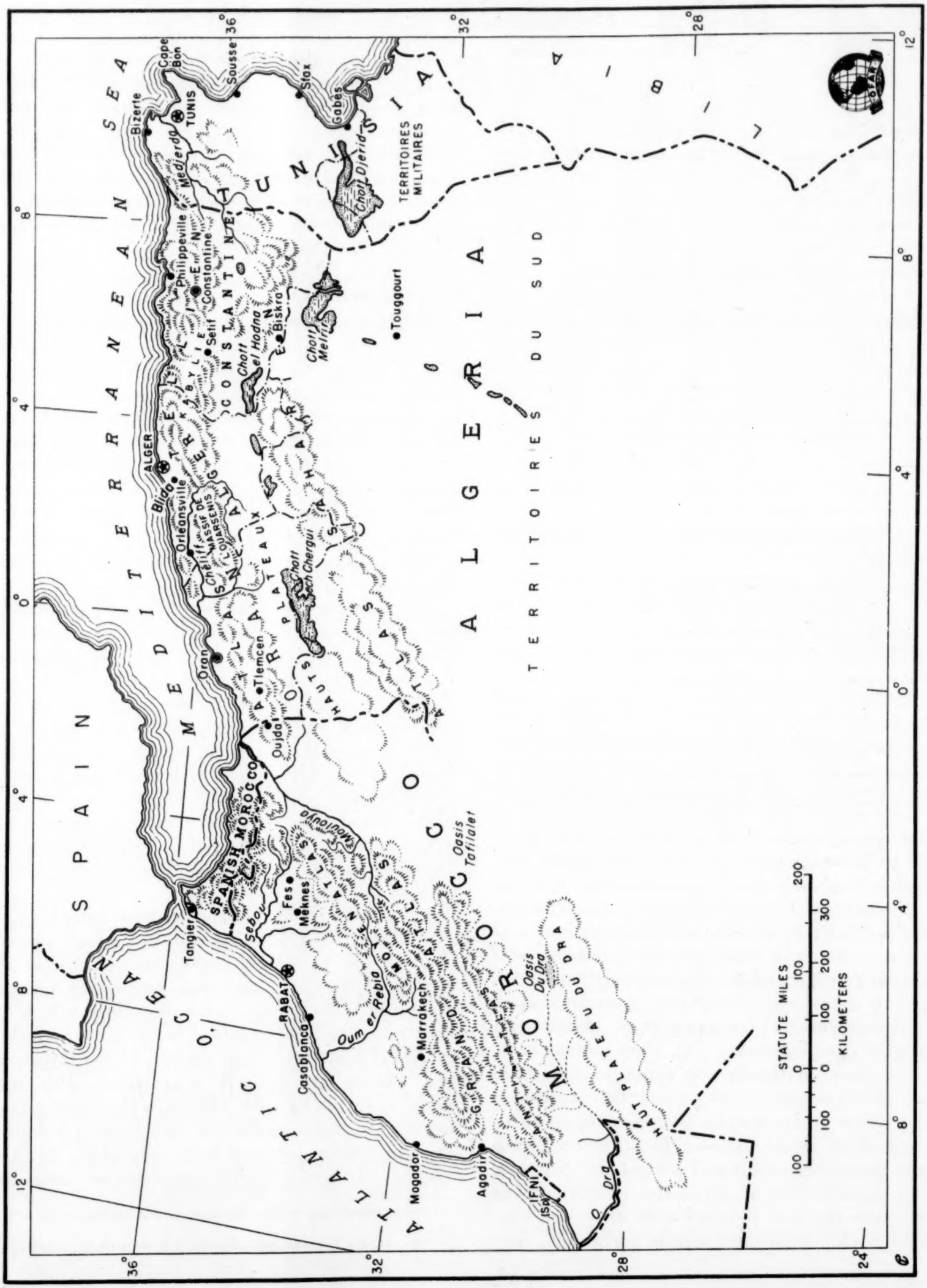

FIGURE 1.—Reference map of French North Africa.

and seminomadism varies from one part of the region to another in accordance with variations in rainfall and other water supplies.

In proportion to their numbers, European farmers own a large share of the cultivated land. Moslem producers, however, hold more than four-fifths of the field-crop acreage, and possess nearly all the cattle, sheep, and goats. Almost the only agricultural enterprises in which Moslems do not predominate are wine and pork production, consumption of both of which is prohibited by the Koran.

Field Crops

Wheat and barley are the great field crops of French North Africa. In the period 1933–37 they occupied 44 and 40 percent, respectively, of the sown acreage. Another 10 percent was planted to other grains, mostly corn and oats. Less than 3 percent was devoted to dry legumes, little more than 1 percent to forage crops, and about 2 percent to other crops, such as flaxseed, tobacco, cotton, coriander, and cumin.

Nearly as much land lies fallow as is sown, the typical rotation being grain-fallow. Part of the fallow land is cultivated in the fall and spring following the harvest. More commonly, however, the spontaneous vegetation is permitted to grow and is utilized as livestock feed.

Farming practices of Europeans and Moslems contrast sharply. Although some Moslems have adopted the modern production techniques widespread among the Europeans, most producers continue in the ancient way. The land is prepared for sowing with archaic wooden plows, having perhaps a metal plowshare or point, which cannot go much below the surface of the soil. Once planted, the fields receive little, if any, attention. Grain is harvested with sickles, threshed with flails or treaded out by cattle, and winnowed by tossing in the air. The use of primitive methods on lands frequently less well suited to cultivation than those of the Europeans explains the low yields obtained by Moslems as compared with those obtained by Europeans. Since estimates of Moslem and European production are given only for Algeria, and in any case must be rather rough, differences in average yields cannot be measured with great precision. It is interesting to note, however, that, according to official estimates, Moslem wheat yields in Algeria averaged only 6 bushels per acre in 1933–37, whereas European wheat yields in the same period averaged 12.5 bushels. On the other hand, Moslem costs of production are much lower.

Both durum and common types of wheat are produced in French North Africa, the Moslems growing mainly durum and the Europeans mainly common wheat. Barley, as well as wheat, occupies a large share of the acreage sown by Moslems, who consume the bulk of what they produce. European grain growers, on the other hand, who produce for the market, have concentrated chiefly on wheat.

Before the war, each of the three French North African countries was generally on an export basis for wheat and barley. Exports were largely directed to France, which gave preferential treatment to colonial goods. French colonial-trade policy undoubtedly played an important part in the striking expansion of French North African wheat and barley cultivation in the interwar period (table 2). Production increased more than acreage between the 5-year periods of 1923–27 and 1928–32, but the next 5 years brought lower unit yields on the average. Nevertheless, net wheat exports were maintained at high levels during the period 1933–34 to 1937–38 as a whole, though Tunisia became a net importer in two seasons and Morocco in one. Net exports of barley, however, fell heavily, reflecting a Tunisian deficit in three seasons and a Moroccan deficit in a fourth.

FIGURE 1.—Reference map of French North Africa.

TABLE 2.—*Acreage, production, net exports, and apparent utilization of wheat and barley in French North Africa, 1923–37*

Commodity and period	French Morocco		Algeria		Tunisia		French North Africa			
	Acreage	Production	Acreage	Production	Acreage	Production	Acreage	Production	Net exports [1] [2]	Apparent utilization [1]
Wheat:	*Thousand acres*	*Million bushels*	*Thousand acres*	*Million bushels*	*Thousand acres*	*Million bushels*	*Thousand acres*	*Million bushels*	*Million bushels*	*Million bushels*
Average										
1923–27	2,439	23.4	3,492	27.6	1,530	9.6	7,461	60.6	5.7	54.9
1928–32	2,777	27.1	3,771	30.2	1,974	13.6	8,522	70.9	17.2	53.7
1933–37	3,212	24.3	4,149	34.4	1,871	13.1	9,232	71.8	16.6	55.2
Barley:										
Average										
1923–27	2,982	40.2	3,274	31.5	1,092	6.8	7,348	78.5	9.2	69.3
1928–32	3,175	47.9	3,422	35.3	1,327	10.7	7,924	93.9	12.4	81.5
1933–37	4,159	52.8	3,180	34.1	1,149	8.2	8,488	95.1	7.8	87.3

[1] Consumption year beginning July 1 or Aug. 1 of year specified.
[2] Including flour in terms of wheat.

Compiled by the Office of Foreign Agricultural Relations from official sources and the INTERNATIONAL YEARBOOK OF AGRICULTURAL STATISTICS (*4*) and (*5*).

Wheat and barley acreages continued to move irregularly upward through 1941 and then commenced a decline that had not been arrested by 1944. The effect of this decline on output was strongly accentuated by unfavorable weather conditions. Production in the 3 years 1942–44 probably averaged little more than in the middle twenties. With a population over 50 percent larger in 1943 than in 1926, French North Africa might well have had no grain to export in the past few years even under normal circumstances. Under wartime conditions, which, as in most other countries, have stimulated hoarding and black-market operations, official collections could not cover ration needs.

Wine

French North Africa is one of the leading wine-producing regions of the world and the largest exporter of wine. Most of the vineyards lie in the Algerian Tell, especially in the Departments of Oran and Algiers. Tunisia has about 10 percent of the total acreage under vines, concentrated mainly in the district of Tunis and on Cape Bon, whereas Morocco's share is only 5 percent, Meknès being its chief wine region.

Wine production is a European enterprise. Italians own a major share of Tunisia's vineyards, and Spanish wine producers have considerable importance in the Department of Oran (*3*, p. 207); but, by and large, the industry is the work of Frenchmen. The methods employed and the final product resemble those of southern France.

Cultivation of the vine in French North Africa was strongly stimulated toward the end of the nineteenth century, when phylloxera ravaged French vineyards and France commenced to import large quantities of wine. Algerian wines entered France freely, and, in 1890, Tunisian wines were given preferential treatment. By 1933–37, vines covered over 1 million acres, wine production averaged 500 million gallons, and exports 360 million gallons, nearly all of which went to France. At the same time, French wine production had also shown a marked increase; and, with the onset of the depression, attempts were made to restrict vine growing both in France and in French North Africa.

During the second World War, North African wine production fell below the prewar average, partly as a result of the deterioration of vineyards. Exports were eventually reduced to insignificant quantities; and, though substantial quantities of wine were distilled into alcohol for fuel, a large surplus has accumulated.

Olive Oil

French North Africa has great importance as a producer of olive oil, as well as of wine. The olive-oil industry is heavily concentrated in Tunisia, which accounted for nearly two-thirds of the average production of oil, 80,000 short tons, during the 10 years ending in 1937–38.[4] Tunisian production centers largely near the coast, in the region of Sousse and of Sfax where dry-land olive culture has been highly developed. Reclamation of these areas, which had extensive olive orchards in Roman times, was begun by the Moslems in the middle of the nineteenth century (*7*, p. 12), and the work was greatly intensified after the occupation of the country in 1881. In 1938, out of a total of 17,500,000 olive trees in Tunisia, the region of Sousse had 7,500,000, and that of Sfax nearly 5,000,000. The only other region of much significance is Tunis, with 3,000,000 trees, most of them old.

In Algeria, on the other hand, the olive-oil industry has shown a decline in recent decades. Production, which comes mainly from the Departments of Constantine and Algiers, amounted to little over one-fifth of the North African output in the 10 years ending in 1937–38. Morocco, principally the regions of Fez and Marrakech, contributed one-seventh of the total for the period.

A large part of the production was exported in prewar years. The bulk of the exports went to Italy, which imported especially Tunisian oil for treatment and reexport, and to France, which was the chief purchaser of Algerian oil, and ranked next to Italy as a purchaser of Tunisian oil. Moroccan exports were usually negligible, but they increased sharply in 1936–38.

On the other hand, although the region had substantial exports of olive oil, its imports of other vegetable oils were also considerable. Tunisia alone had an export surplus of edible oils, but this surplus hardly compensated for the deficits of Algeria and Morocco. During the last 5 prewar years, when net exports of edible olive oil from North Africa averaged 50,000 short tons, net imports of peanuts and peanut oil alone averaged about 49,000 short tons in terms of oil equivalent.

The war period brought a drastic decline in both imports and exports of oil. Though production was fairly well maintained on the average, olive-oil crops were very short in several years. Moreover, the situation was aggravated by the impossibility of effecting a reasonably equitable distribution of supplies

[4] For regions of olive culture in French North Africa, see (*6*, maps XVI, XVIII, and XIX).

throughout the region. Acute shortages of oil developed in Algeria and Morocco, and even in Tunisia the supplying of urban areas became a problem. Until the supply of food and consumer goods in general improves, distribution difficulties seem likely to continue to keep commercialized production and exports at low levels in relation to total output.

Fruits and Vegetables[5]

Aside from grapes and olives, the principal fruits grown in French North Africa are figs, dates, and citrus. Figs, found chiefly in the coastal zone, are mostly cultivated and consumed by the Moslems. Only small quantities of dried figs are exported.

Dates are the great product of the oases. The finer varieties, particularly the Deglet Noor, are produced mainly for export, and the commoner types form a staple item in the diet of the Moslems. Usually Algeria and Tunisia are on an export basis for dates, but, in years of small crops, imports may exceed exports. Morocco's output does not cover its requirements.

Citrus fruit is raised chiefly by Europeans near the coast, where the climate is mild and sufficient water for irrigation is available. Algeria has the largest share in production, which consists mostly of oranges and mandarins. Exports from all three countries increased substantially in the period 1935–38, when all showed an export surplus.

Truck gardening for commercial purposes is also largely confined to the irrigated areas of the coast. A wide variety of vegetables is grown, and in normal times substantial quantities are exported, especially in the late winter and early spring. During the period 1933–37, net exports of fresh vegetables, consisting mostly of tomatoes, artichokes, carrots, beans, and peas, averaged some 70,000 short tons. In addition, potato exports, chiefly from Algeria, averaged nearly 71,000 short tons; but imports averaged almost 87,000 short tons, French North Africa relying on imported potatoes for most of its seed and part of its requirements for consumption.

Livestock

Stock raising, which is almost entirely in the hands of the Moslems, is a leading agricultural enterprise. It is based for the most part on the spontaneous vegetation which springs up after the first autumn rains, even in the desert, but dries out nearly everywhere in the summer. When the rains come later or are unusually light, the livestock, already in poor condition as a result of meager feeding during the summer months, suffer severely. Their endurance is further tested by a general lack of shelter or other provision for their well-being. The animals which can withstand this treatment are tough, hardy, slow to develop, and rather low yielding.

Sheep and goats are the most numerous kinds of livestock in each of the French North African countries (table 3). They pasture together throughout the region. Some flocks stay the year round in the coastal zone, either remaining in the same locality, or moving comparatively short distances. Many pass the year on the high plateaus, migrating from one part to the other. A third group travels between zones, sometimes from the desert as far as the coast.

TABLE 3.—*Livestock numbers in French North Africa, average 1933–37*

Type	French Morocco		Algeria		Tunisia[1]	French North Africa
	Total	Percentage Moslem-held	Total	Percentage Moslem-held		
	Thousands	*Percent*	*Thousands*	*Percent*	*Thousands*	*Thousands*
Sheep	9,120	97.5	5,861	92.4	3,271	18,252
Goats	5,384	99.3	2,825	98.3	1,801	10,010
Cattle	1,595	96.2	862	87.3	494	2,951
Hogs	83	1.3	58	(1)	21	162
Horses	216	94.8	175	74.1	106	497
Mules	128	91.0	182	66.2	53	363
Asses	717	99.4	344	98.4	173	1,234
Camels	155	99.5	175	99.8	167	497

[1] Moslem- and European-held livestock not separately distinguished.

Compiled by the Office of Foreign Agricultural Relations from official sources.

Among the three principal breeds of sheep distinguished in North Africa, the Arab predominates.[6] It has a white, brown, or black head; a thin tail; and thick, usually short, curly, relatively fine wool. Barbary sheep, the prevailing breed in Tunisia, are characterized by their fat tails. The Berber breed, confined to the mountainous regions of the coastal zone, is marked by its long, coarse, straight wool, somewhat like goat hair. Imported breeds or crosses with native sheep, found mainly on European farms, are numerically unimportant. As for goats, most are of local origin, though the higher milk yielding Maltese goat has some significance, at least in Tunisia.

The Moslems depend heavily on sheep and goats for the necessities of life, including meat, milk, clothing, shelter, and bags for carrying water, oil, etc. These animals are also an important source of cash income, which is derived from sales at home and abroad. In the 5 years 1933–37, French North Africa exported on balance an annual average of 900,000

[5] Horticulture in Algeria and Tunisia is discussed in some detail in (*3*, pp. 184–192 and 217–233) and in (*10*, pp. 261–279).

[6] For a detailed description of livestock breeds in French North Africa, see (*9*, pp. 271–377).

sheep and lambs, mostly to France, where many were fattened. Mutton, wool, and skins made considerably smaller contributions to the export trade.

Cattle are largely restricted to the coastal zone. Local breeds, which constitute the bulk of the cattle population, belong to the same general North African type, characterized by its small size, hardiness, and low milk yields. Crosses with European breeds and with the zebu are few in number, as are the imported milk cows found near some urban centers.

The Moslems keep cattle mainly for work and meat. European farmers frequently engage in the fattening of cattle, buying them from the Moslems in the late summer and fall, and selling them in the spring. Some of the animals are exported; in the prewar period cattle exports exceeded imports. At the same time, French North Africa had a net import of beef as such. It was also on a deficit basis for milk, butter, and cheese.

Work animals include horses, mules, asses, and camels, in addition to cattle. Horses belong mainly to the Berber breed whose members, while small, are noted for their sturdiness, resistance to fatigue, and capacity for work. Berber horses are raised for the Army, as well as for work in the fields and hauling. In some sections a cross between the Berber and Breton is common. Mules, sometimes the offspring of Catalonian or other European asses and Berber mares, are also employed, chiefly as draft animals. Camels in the desert and asses elsewhere are the main beasts of burden, although the mehari, a variety of the dromedary or one-humped camel of North Africa, is used for riding.

In contrast to the other animal enterprises, hog production is left mostly to the Europeans. Both local and improved breeds are raised. The hog industry, though small, was able to supply more than the number required in the restricted domestic market before the war. In the 5 years 1933–37, net exports averaged 30,000 head.

Poultry keeping is fairly widespread among the Moslems. Generally the fowls are allowed to shift for themselves. Egg production exceeded domestic requirements in the prewar period, net exports of eggs in the shell averaging 26 million pounds a year during 1933–37.

During the first war years at least, numbers of work animals were well maintained; the cattle, and especially the sheep, goat, and pig, population showed a substantial increase. At the same time, exports dwindled, and livestock products became very scarce in urban areas. With a marked shortage of goods producers buy, resulting from wartime restrictions on imports, the Moslems evidently preferred to keep their capital in the form of livestock rather than save paper money. In the past few years, lack of feed has cut pork production, and drought has probably caused a reduction in cattle, sheep, and goat numbers. Controlled supplies of livestock products, however, have apparently shown little improvement.

Trade in Agricultural Products

Agriculture, normally the mainstay of French North Africa's export trade, contributed some four-fifths of the value of all exports in 1933–37. The proportion rose to nearly nine-tenths in Algeria, by far the largest exporter among the three countries, but dropped to around two-thirds in Tunisia and Morocco, which outranked Algeria as exporters of mineral products. Well over half the value of mineral exports came from rock phosphate, North Africa furnishing one-half of world exports of this fertilizer material in the last prewar years.

Among agricultural products, wine and cereals are ordinarily the great exports. During the period 1933–37, wine and spirits alone accounted for 45 percent of the value of agricultural exports, and grains and their products for 22 percent. Almost another 12 percent was derived from fruits and vegetables, over 9 percent from live animals and livestock products, nearly 6 percent from vegetable oils, and about 6 percent from other agricultural products, including tobacco, tobacco products, alfa grass and other vegetable fibers, and medicinal plants.

While North Africa was a net exporter of agricultural products before the war, agricultural imports were not unimportant. The principal food imports included sugar, which is not produced in the region; vegetable oils; meat as such; dairy products; coffee; tea; and fruits and vegetables, such as bananas, apples, dates, and potatoes.

France has been the leading purchaser of North African agricultural exports and, together with the French Empire, furnished a large part of the agricultural products imported by the region in the prewar period. French trade policy has long promoted intraimperial trade. Algeria has had an almost complete customs union with France since 1884. Tunisia, which had been granted major concessions on its most important exports as early as 1890, was, except for wine and alcohol, which entered duty-free within a quota, included in the Franco-Algerian customs union under the law of March 30, 1928, and the subsequent decrees (*1*, p. 13E). French Morocco, though prevented by international agreements from favoring French goods, has been allowed since 1923 to export

to France, free of duty, specified quantities of a number of agricultural products. During the depression, the margin of preference for colonial goods was increased as France tightened trade restrictions on foreign goods. In the period 1933–37, France accounted for nine-tenths of Algerian agricultural exports. Its share in Moroccan and Tunisian agricultural exports was considerably lower, amounting to something less than two-thirds of the total; but, if exports to Algeria are included, the proportion rises to three-quarters in the case of Morocco, and to seven-tenths in the case of Tunisia. Algerian exports to Tunisia and Morocco, as well as trade between the latter two countries, were insignificant.

Trade between France and French North Africa, which showed a considerable decline in the early war years, was cut off in November 1942, when the Allies landed on the African coast, and resumed following liberation of the mother country in the summer of 1944. As has been indicated earlier, North Africa has few food surpluses available for export at present, and the shipping shortage constitutes another limiting factor. With the return of more normal physical and economic conditions, however, North Africa will probably again become a surplus producer of foodstuffs and an important source of food supplies for France.

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United Kingdom Cattle-Production Policy

by **DAVID D. JONES***

The United Kingdom Government has guaranteed prices of beef cattle since 1934 and has recently announced that currently prevailing prices will be assured up to the summer of 1948. By this guaranty and other means, the Government is encouraging high postwar production levels. Cattle numbers in the United Kingdom have already increased appreciably over the prewar level. Dairy herds have taken precedence over other livestock in the allocation of rationed feedstuff concentrates, but beef-cattle numbers have also been well maintained by increased production of other feedstuffs.

*Office of Foreign Agricultural Relations.

Government Controls

As far back as 1932, the domestic livestock industry in the United Kingdom received governmental assistance through restrictions of meat imports under the Ottawa Agreements Act. The period from July 1, 1931, to June 30, 1932, known as the "Ottawa Year," was taken as the basic year, and foreign imports were restricted to an agreed percentage of the imports during that time.

Imports of live cattle were restricted by the Cattle Industry (Emergency Provisions) Act in 1934, when a subsidy was granted, which continued unchanged

until 1937, although it had originally been intended as only a temporary measure to help the industry until imports of meat could be further restricted, or until demand increased. Under the provisions of this act, Exchequer grants up to £3 million a year were paid into a cattle fund administered by a cattle committee. The prices fixed for cattle were based on current competitive market prices, to which were added the subsidy payments on all cattle meeting official standards. These measures, however, which were adopted to assist the industry, were considered to be of a palliative nature only and were not expected to place cattle production on a self-supporting basis, unless demand increased substantially.

Consequently, under the Livestock Industry Act of 1937, subsidy payments were placed on a quality scale to encourage the improvement of livestock. Animals were examined at approved certification centers for a small fee, which was applied toward the expense of maintaining the centers. The act also established an appointive Livestock Commission, which was concerned with the adoption of better marketing methods and facilities and the reduction of costs through the improvement of markets and slaughterhouses, establishment of experimental slaughterhouses, and promotion of research and education. A Livestock Advisory Committee, representative of all livestock interests, was also appointed to assist the Commission.

Exchequer grants up to £5 million a year were made available in 1937 for a cattle fund. From this fund, in turn, were paid all subsidies, reimbursements to the Ministry of Agriculture and Fisheries for any expenses incurred relative to subsidies, all expenses of the Livestock Commission and the Livestock Advisory Committee, and the working costs of making the subsidy payments. Although the advent of war, soon after the establishment of the Commission, prevented it from proving itself to any degree, from 1937 some effort was apparently made to develop the beef-cattle industry along economic lines; whereas, before that time, the industry had been benefiting from Government payments without any inducement to increase its own efficiency.

Early in 1940, the newly formed Ministry of Food assumed control over all domestically killed meat. It has since bought all livestock offered for sale at fixed prices and has required farmers to give 12 days' notice to the appropriate designated collecting center of the number of animals they desire to sell.

Private slaughter of cattle was prohibited in January 1940. Fat cattle going to the above-mentioned collection centers are there graded on the hoof by a panel of three, composed of a farmer, a butcher, and an auctioneer. The animals are then consigned to centrally located area slaughterhouses. After an animal is slaughtered, the carcass is checked for quality and weight against the grading made at the collection center. Prices are specified in advance and are based upon weight and grade, varying in accordance with seasonal conditions.

Up to February 1941, concentrated-feedstuff supplies were allocated by the Government to merchants, and by the latter to their customers, on the basis of prewar purchases. After that time, as a result of experience with uneven distribution, and because of increasing shortages, a rationing scheme for concentrated types of feed was instituted, based on a livestock-priority scale. In practice, dairy animals were the only type to benefit substantially by such distribution. Home production of bulky items has, however, greatly increased, and these items have remained unrationed. Farmers are also allowed to keep any home-grown feed grain, although the amount of the latter is taken into consideration when an individual's ration allowance is determined by the feedstuffs officers of the respective County War Agricultural Executive Committees. Farmers are required to register with not more than three supply merchants and to deposit their coupons within a few days after receipt with the merchants selected, thus enabling the latter to order the supplies needed.

For the year 1943–44, the cattle subsidy was estimated at £7 8s. 3d. ($29.91) per head slaughtered. Furthermore, a special bonus of £3 ($12.10) per head is currently being paid to farmers to encourage cattle raising on hills otherwise unprofitable.

Trends in Cattle Numbers

Reflecting the efforts of the Government, as outlined above, the total cattle population of the United

TABLE 1.—*Number of cattle in the United Kingdom as of June 1, 1930–44*

Year	Cows and heifers in milk and in calf	All other cattle [1]	Total
	Thousands	*Thousands*	*Thousands*
1930	3,384	4,374	7,758
1931	3,504	4,451	7,955
1932	3,605	4,701	8,306
1933	3,710	4,938	8,648
1934	3,775	4,967	8,742
1935	3,828	4,831	8,659
1936	3,846	4,777	8,623
1937	3,823	4,816	8,639
1938	3,835	4,926	8,761
1939	3,884	4,988	8,872
1940	3,958	5,136	9,094
1941	3,988	4,952	8,940
1942	4,200	4,876	9,076
1943	4,324	4,936	9,260
1944	4,377	5,168	9,545

[1] Wartime statistics published by the British Ministry of Agriculture and Fisheries do not show beef-cattle numbers separately.

Official statistics.

TABLE 2.—*United Kingdom beef and veal supplies, 1930–39*

[Dressed weight, exc. offal]

Year	Domestic production	Imports	Total supply
	Million pounds	*Million pounds*	*Million pounds*
1930	1,304	1,286	2,590
1931	1,236	1,328	2,564
1932	1,194	1,268	2,462
1933	1,243	1,258	2,501
1934	1,373	1,314	2,687
1935	1,469	1,296	2,765
1936	1,501	1,328	2,829
1937	1,456	1,378	2,834
1938	1,355	1,404	2,759
1939	1,404	1,397	2,801

Compiled from official statistics.

Kingdom increased by 10 percent from an average of 8,675,000 in 1936–38 to 9,546,000 in 1944. Although the total was almost stationary during 1935–37, an upward trend in dairy cattle began in 1938, which has been accelerated in recent years. A gain of about 1 million in cows and heifers in calf was indicated in 1944 as compared with 1930, when no Government controls or assistance had been undertaken (table 1).

Beef-cattle numbers are not separately shown in official United Kingdom figures, but any reduction of these would seem to have resulted principally from a wartime diversion of greater-than-usual numbers of dual-purpose cattle to dairy use, considering the substantial increase in total numbers of cattle of all types during the period. A high level has been maintained during the war, despite the shortage of concentrated feedstuffs resulting from a decline of almost 7 million short tons in such imports, a diversion of cereals to human consumption, a shortage of skilled labor, and the plowing up of 7 million acres of grassland, which was brought under emergency tillage. In addition, fewer Éireann store (feeder) cattle have been imported than before the war, and the fattening period has, under wartime feeding conditions, grown longer. As a result of the ban on the importation of store cattle from Éire for the greater part of 1941, because of a serious outbreak of foot-and-mouth disease in that country, British feeders were denied access to their principal outside source of stock replacements, which adversely affected both cattle numbers and the meat supply. Finally, older dairy cattle destined for slaughter have been retained in milk production longer than usual; consequently, this source of beef was reduced.

During the war, domestic beef and veal production has declined by an estimated 20 to 25 percent from the prewar level. In 1934, domestic production constituted approximately half of all carcass beef and veal consumed in the United Kingdom (table 2). The percentage was somewhat increased by the prewar limitation placed on imports and, more recently, by the reduction of imports as a result of the war.[1]

TABLE 3.—*Cattle numbers in the United Kingdom by selected types, June 1, 1939–44*

Type	1939	1940	1941	1942	1943	1944	Percentage change 1944 of 1939
	Thousands	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Percent*
Cows in calf but not in milk	480	488	524	588	640	651	+35.6
Heifers in calf	564	621	586	802	774	795	+41.0
Bulls for service	114	115	115	125	131	133	+16.7
Other cattle:							
2 yrs. and over	1,229	1,301	1,167	1,214	1,226	1,359	+10.6
1–2 yrs	1,867	1,857	1,893	1,693	1,726	1,785	−4.4
Under 1 yr	1,778	1,863	1,777	1,844	1,853	1,891	+6.4
Total	4,874	5,021	4,837	4,751	4,805	5,035	+3.3
Total	6,032	6,245	6,062	6,266	6,350	6,614	+9.6

Based on official statistics.

Official Postwar Plans

The Minister of Agriculture, on December 5, 1944, indicated to the House of Commons that the probable change in the character of British agricultural output necessary during the transition to peace would mean a gradual expansion of livestock and livestock products and a reduction from the high wartime levels of certain crops for direct human consumption. He summarized the Government's price policy for the transition period as follows:

> To encourage a substantial increase in milk production and a revival in the rearing of cattle and sheep for meat production, an assured market and guaranteed minimum prices are being provided for milk, fat cattle, sheep and lambs, and calves until the summer of 1948. Actual prices will be considered at each February review, and subsequently fixed by the Government.

That there is a probability of increased production of beef and veal, and possibly also of milk, in the offing, is evidenced by the upward trend in cattle numbers, particularly of heifers in calf (table 3).

Out of concern for increased quality of both beef and dairy cattle, the Government is establishing, under strict licensing, artificial-insemination centers. The United Kingdom still has large numbers of dual-purpose cattle, some of which are the product of careful selective breeding and others of poor-grade stock. Wartime experience, however, especially in connection with the important milk-production program, has stimulated efforts to improve the ordinary farm herds. At the beginning of this year, the Ministry of Agriculture introduced a new system of bull licensing, which provides for a beef, a dairy, and a general

[1] For milk production, see p. 283 of Jones, David D., UNITED KINGDOM WARTIME POLICY AND POST-WAR PROGRAM FOR MILK. Foreign Agr. 8: 282–284.

license. Hope has been expressed that the general license will be gradually eliminated. A dual-purpose bull, however, can qualify for a dairy, as well as a general, license, and that type of animal will probably retain a significant place among the country's cattle, at least in the immediate future.

To make certain of adequate meat supplies in the post-war period, the United Kingdom has entered into long-term contracts with Australia and New Zealand to take their exportable surpluses of meat, including beef. These contracts are due to expire on September 30, 1948. A similar agreement has been entered into with Canada, involving its exportable beef surplus for each of the years 1944, 1945, and 1946. Furthermore, the United Kingdom has, for the past several years, been the sole buyer for the United Nations of the exportable beef surpluses of Argentina, Uruguay, and Paraguay.

The Government has attempted to stabilize, as far as possible, the uncertain future of cattle prices by guaranteeing them up to the summer of 1948 at not less than those presently prevailing. Each February, representatives of the Ministry of Agriculture and Fisheries and the farmers' unions are jointly to review the general financial position of agriculture in the United Kingdom, according to the economic and financial information available. Any annual adjustments in the price of beef cattle that may be made as a result of such review will relate to prices from July 1 of the same year.

Prices per hundredweight (112 pounds) for fat cattle during the 1934–38 period averaged £2 2s. 10d. ($10.60) and, in 1943–44, £3 4s. 10d. ($13.08). In July 1944, prices for live fat cattle were increased by an average of 2s. ($0.40) per hundredweight for the 1944–45 season, including quality premiums. The price was raised by an additional 2s. 6d. ($0.50) as a result of the annual price review made in February of this year.[2]

[2] For milk prices, see reference in footnote 1.

Tree Shelterbelts At a Soviet Experiment Station

by **THEODORA MILLS***

For the past 50 years, experiments in Russia have been carried on with tree shelterbelts to improve crop production and reduce the hazards of a rigorous, arid climate. Much of this work has been done at Kamenno-Stepnoe station in southeastern European Russia. The experiments there with quadrilateral belts occupying 10 percent of the area to be protected and combined with crop rotations including 20 percent of perennial grasses were found to give the best results.[1]

Russian scientists have pioneered for many years in the study of tree shelterbelts and their effects upon wind and drought. The oldest experimental station where such work has been carried on is Kamenno-Stepnoe in semiarid southeastern European Russia.

The results of experiment work by this station show that yields are improved and the effects of wind and drought are reduced if wide tree shelterbelts are planted completely around croplands on which are practiced rotation schemes, including 20 percent of perennial grasses. The problem of this semiarid region where spring droughts are particularly damaging can be solved only with a combination of factors. Tree belts alone did not suffice; they had to be wide and they had to enclose separate fields in order to be most beneficial. Even with such tree belts occupying 10 percent of the area to be protected, results were not greatly improved until the crop rotation included two successive crops of perennial grasses. To the parts of the United States suffering from similar climatic conditions the results of these Soviet investigations may be of particular interest.

*Office of Foreign Agricultural Relations.

[1] Based upon a report by L. G. Michael, U. S. Agricultural Attaché to the Soviet Union, who visited the Kamenno-Stepnoe Experiment Station in 1944, and supplemented by an article on the research work of the station written by A. Krylov, its director, OPYT RABOTY KAMENNO-STEPNOE STANTSI. Sotsialist. Selskoe Khoz., No. 1, 1944: 35–44, illus.

Location and History of the Station

Kamenno-Stepnoe State Genetical Experiment Station is in the Voronezh Province, 175 miles east and south of the city of Voronezh. Its location, 51°3′ north latitude and 40°42′ east longitude, places it a little north of Kharkov and approximately 170 miles east of that city.

The region's physical features—both favorable and unfavorable—define the experimental problems of the station. The fertile black soil (Chernozem), 23.6 to 27.6 inches (60–70 centimeters) in depth and

averaging 8 to 11 percent humus content, is favorable for grain crops. The nearly level topography is convenient for cultivation but also for wind damage to soils and crops.

The climate is continental in character, with average temperatures (1915–28) for May, June, and July of 79.5° F., 74.1°, and 77.5°, respectively. This provides an adequate growing season. The winters are cold, with a record low of −34.6° F. In addition to a wide seasonal range in the temperature, farming is further complicated by intraseasonal variations. In summer, strong, hot winds from the desert may raise the temperature to 113° F., and in September killing frost begins, which may continue into May. For example, on April 27, 1930, the temperature was 14° F., and on May 17, 1938, 24.8° F.

The deficiencies of the annual precipitation constitute a major problem for research and give the agriculturists of the vast Don-Volga region much trouble. The average yearly precipitation varies usually between 11.8 and 15.8 inches (300–400 millimeters). The maximum range recorded is between 11.2 and 27.4 inches (285–695 millimeters). The distribution is even more unfortunate than the total amount because of a tendency to spring droughts. The average percentages of precipitation for each quarter of the year are 7.0, 30.0, 41.4, and 21.6, respectively. The rainfall is not torrential. Winter snows blown by the east winds across the steppe tend to collect in drifts and denude the fields of protective cover.

This physical picture indicates that in order to raise yields and especially in order to ensure against crop failures, measures need to be developed for combatting wind and drought, and conserving moisture.[2] The 50-year history of the Kamenno-Stepnoe station tells the story of this effort.

In 1892, the station was founded by the famous Russian soil scientist V. V. Dokuchaev. It was under his direction until 1909 and continued thereafter to follow the research policies which he had introduced. He proposed to study the problems of drought and erosion and measures for their alleviation, especially by means of protective forests.

The success of the station in developing measures of drought alleviation was somewhat limited as long as experimentation was restricted to the study of shelterbelts alone. After 1935, under the direction of V. R. Williams, the key to the problem was found. By initiating the practice of crop rotations with 20 percent grass, a marked improvement was shown. More suitable crop rotation improved yields and noticeably increased the benefits obtained with shelterbelts. The combination of methods suggested by Dokuchaev and Williams brought the favorable results that will be considered in greater detail.

[2] TULAIKOV, N. M. AGRICULTURE IN THE DRY REGION OF THE U. S. S. R. Econ. Geog. 6: 54–80, illus. 1930. (Trans. by J. W. Pincus.)

Description of the Station

Although many factors in a description of the station have been mentioned above, a more detailed picture is necessary to portray the experimental facilities and methods used there.

The main part of the station spreads over 8,042 acres of plateau, which slopes gently from the northwest to a creek running in a southerly direction. The altitude varies between 574 and 640 feet (175–195 meters), with the creek dropping from 492 to 476 feet (150–145 meters). A subsection of the station occupying 605 acres (245 hectares) is located approximately 4 miles farther down the stream. It contains the largest (about 15 acres or 6 hectares) of the 8 ponds used for irrigation experiments on vegetable fields. Some of these ponds are merely collected runoff water. Their total area is 28.3 acres (11.45 hectares). They are also used by ducks and geese, and the hope is that later they will be stocked with fish.

The main section is divided into four parts. The largest one, of about 2,471 acres (1,000 hectares), is covered with shelterbelts of various widths and shapes, which enclose approximately 25 fields, ranging between 6.18 and 148.3 acres (25–60 hectares) in size. These fields were subdivided in 1944 into 102 plots. A few of the enclosed fields were not subdivided but were cultivated as 148.3-acre units (60 hectares), which size is considered in this region to be the best for mechanized agriculture.

The second largest part, 1,730 acres (700 hectares), serves as a control and is devoid of trees but is divided into plots corresponding to the first part. A third part, 124 acres (50 hectares), which has never been plowed, serves as an additional control indicating what nature, unaided and unhindered by man, produces on the steppe. This natural growth is further observable in a fourth part, 22 acres (9 hectares), which was last plowed in 1882 and has since been left untouched to reseed itself with whatever comes. Approximately 40 different kinds of trees and shrubs are growing in these natural areas, as well as grasses, some of which are used for pasture.

The work of the staff consists of experiments with tree shelterbelts, crop rotations, irrigation, selective breeding of seeds, beekeeping, and livestock farming. In 1944, there were 118 hives of bees, 121 work horses, 234 cattle of all ages, 120 hogs, 113 sheep, 700 chickens, and a few ducks and geese. The type of

farming carried on by the station could utilize more livestock, according to the director, but barn space at present is limited.

The station includes also a repair shop for the 15 tractors and other machines, a brick works, and plans have been made for a flour mill. The main administration building houses a museum and the necessary laboratories for forest and genetic research.

Experimental Work on Crop Rotations

Much of the research at Kamenno-Stepnoe is concerned with crop rotations, in connection with the shelterbelts, with the development of high-grade seeds, and with methods of irrigation.

The effect of grass rotation upon the value of tree belts, however, was particularly significant, as the history of the station indicates. A crop rotation, especially a 10-crop one in which perennial grass follows upon perennial grass, was found to increase the effectiveness of the shelterbelts. (See tables 1 and 2.)

Shelterbelts

THE PROBLEM OF WIND AND DROUGHT

In the vast Don-Volga region, the strong east winds blowing from the deserts of Central Asia and the inadequate rainfall are the principal farming hazards. A knowledge of their unfavorable effect on soil and growing plants is helpful for an understanding of the beneficial results obtained from shelterbelts.

Strong winds affect both the soil and plants. The wind sweeps the fertile topsoil from the plants. In the spring and summer the wind from the hot desert scorches the crops, making the plants transpire more rapidly and therefore wilt sooner. In winter the wind piles the snow in drifts, often stripping fall-sown crops of their snow blanket and thus allowing the ground to freeze harder and deeper. With inadequate snow, there is less moisture to percolate down into the ground when the spring thaws come.

TABLE 1.—*Yields of spring wheat grown under different conditions*

Preceding crops	On the open steppe		Within forest belts	
	Without fertilizer	With fertilizer	Without fertilizer	With fertilizer
	Bushels per acre	*Bushels per acre*	*Bushels per acre*	*Bushels per acre*
Legumes and grasses	26.9	31.5	37.6	45.4
Other spring row crops	25.0	28.1	30.6	33.3

Office of Foreign Agricultural Relations.

Inadequate rainfall starves growing plants and is particularly harmful during the early spring growing period. As crops shrivel with a drought, so the ground becomes caked and squeezes plant roots. Then when the rain comes it cannot soak into the soil easily, and much of it runs off, washing off the fertile topsoil and gouging out gullies. Some soils dry out and cake more readily than others. When this happens, surface drainage is said to be poor. If half the rain water that falls is not absorbed, the run-off coefficient is said to be 0.5. Such a poor surface drainage may precipitate floods, because rain washes off the fields into creeks and streams and causes them to overflow their banks. Inadequate surface drainage resulting from poor soils aggravates drought conditions and is in turn made more inadequate by the drought. Water runs off from the soil surface; the deeper layers, in spite of the rain, become drier and drier. In addition, where the soil structure is poor, the counterforce opposing the drying from above—the osmotic pressure which raises moisture in the lower soil levels—is inhibited, and drying proceeds deeper.

Soil structure which retains rain water is drought-resistant. Such soils are found in forests with deep litter and humus deposits. They are coarse-grained and do not dry up to a hard, water-resistant cake but, like a sponge, collect the rainfall and percolate it slowly to deeper and deeper levels.

Shelterbelts are beneficial insofar as they check the force of the wind and directly and indirectly increase the water-holding capacities of the soil. They serve as windbreaks, keeping adjacent soils from being blown away and plants from being shriveled. With the lowered wind velocity, snow remains on the fields, protecting plants from freezing and ensuring moisture with thawing. By facilitating the water-retention capacities of the soil upon which they are located, they conserve ground water, thus indirectly improving the moisture content of adjacent cropped fields. Also, as can be seen from the foregoing discussion, the increased effectiveness of shelterbelts resulting from the concomitant use of crop rotations, with grass succeeding grass, results from the fact that the grasses also keep the soil from being blown by the winds and improve its ability to retain moisture.

The factors that were found to determine the effectiveness of shelterbelts were those increasing wind and drought resistance; they were size, height (largely a function of size and type of trees), and shape. The best results were obtained with wide belts of tall trees and shrubs placed completely around the fields which they were protecting.

TABLE 2.—*Yields per acre of specified crops on steppes and in tree belts*

Item	Spring wheat lucerne-62 on virgin soil	Spring wheat lucerne-62 on turned-over land	Oats *pobeda*	Sunflowers	Winter wheat *gostianum*-267	Grass mixture perennial	Vetch and oats	Beets and other root crops
	Bushels	*Bushels*	*Bushels*	*1,000 pounds*	*Bushels*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*
7-crop grass rotation on open steppe	20.4	21.7	51.9	1.4	27.1			
7-crop grass rotation within tree belt	21.4	23.2	60.5	1.7	34.8			
8-crop fodder rotation on open steppe						4.1	3.0	20.6
8-crop fodder rotation in tree belt						5.3	4.2	35.8

Office of Foreign Agricultural Relations.

EFFECTS OF SHELTERBELTS

Knowing of American work with unilateral shelterbelts set across the path of prevailing winds, and upon the recommendation of the All-Union Scientific Research Institute of Agriculture and Forestry, the Kamenno-Stepnoe station experimented with similar belts from 5 to 7 rows wide (7.5–10.5 meters). They found that the wind velocity was reduced, but such narrow belts acted as windbreaks only and did not produce the other beneficial effects obtainable with wider belts, such as follows: Within a field of 62 acres (25 hectares) surrounded by a forest shelterbelt from 52.5 to 65.6 feet (16 to 20 meters) wide, approximately 10 percent of the enclosed area, the wind velocity was observed to be decreased by from 35 to 40 percent.

Within belts of optimum size and shape (wide, quadrilateral belts occupying 10 percent of the planted area), plant transpiration decreased 30 percent.

The snow cover was one and a half to two times as heavy within the tree belts as on the open steppes. The snow in the protected areas ranged between 11.0 and 25.6 inches (28–65 centimeters) as compared with a range between 5.5 and 14.6 inches (14–37 centimeters) on the steppe.

Shelterbelts were also found to lessen surface drainage. In addition, wider belts reduced it more than narrow ones. Narrow belts, 24.6 to 32.8 feet (7.5–10 meters), amounting to 3 percent in trees, did not prevent gully formation and topsoil washing. Belts comprising 6 percent of the area enclosed were found to reduce the surface drainage one and a half times (run-off coefficient, 0.3) in comparison with unprotected steppes. But a field on a slope of 2 degrees, surrounded by trees to a depth of 131.2 feet (40 meters) was able to absorb all the rainfall. The run-off coefficient on the steppes was found to be 0.5; with optimum conditions of forestation and soil structure, the run-off coefficient was reduced to nothing; and, with 10 percent of a given area in trees where the soil structure was poor, the coefficient was lowered to 0.005. On the steep slopes of gullies and ravines tree planting serves primarily to protect the soil from eroding away entirely, and for this reason requires belts wider than 10 percent.

A deep forest floor is necessary in order to obtain the maximum rain absorption and the greatest protection from frosts. The depth of such a floor was found to be directly related to the width of the surrounding belt; wider belts developed deeper litter layers.

The byproducts of tree planting are in themselves of value. These are: Fuel, lumber, and edible fruits, nuts, and berries. On the treeless steppes of Russia, where barnyard manure is used for fuel and as building material, a source of wood fuel means increasing soil fertility, since manure can be freed from its domestic tasks and put to use as fertilizer.

As with the effect on erosion control, so with the effect on wood production, the size of the forest belts was found to be important. On narrow strips, where there is more sunlight, leaf and branch growth is thick, and tree trunks are short and often gnarled and intertwined. Wide belts produce taller, straighter trees that make better lumber. Without stunting tree growth, greater shading of the soil can be obtained by planting shrubs with the trees instead of obtaining the shading at the expense of the quality of the timber stand.

FOREIGN AGRICULTURE HALLY H. CONRAD, EDITOR

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After many years of study of some current species of trees and shrubs, the more d[illegible]nes were grouped into (1) permanent trees, s[illegible]n-mer oak (*Quercus pedunculata praecox* ash (*Fraxinus excelsior*) and Pennsylv sharp-leaved maple (*Acer platanoides*, L. leaf linden (*Tilia parvifolia*, Ehrh.), and elm (*Ulmus effusa*); (2) temporary kinds, warty birch (*Betula verrucosa*), poplar, and American maple; and (3) shrubs, such as boxthorn (*Amelanchier vulgaris*, Mnch.), hazel bush, Russian maple (*Acer tataricum*), red alder (*Sambucus racemosa*), black alder (*Sambucus nigra*), and yellow acacia *Caragana arborescens*). In forest plantings the most desirable proportions of these three groups were found to be 50–60 percent of the first, 20–30 percent of the second, and 30–10 percent of the last.

Tree belts on steep slopes, as already indicated, present somewhat different problems, since they serve primarily to hold the soil in place. For such plantings, experiments showed that the outer 6 to 10 rows of trees, constituting the protective belt, could be composed of the trees and shrubs listed above, but the inner rows held the soil better if they were made up of cultivated and wild fruits, such as cherry, raspberry, blackthorn, etc.

Two sample plantings are given by Mr. Krylov, one with oak and the other without: (A) 1st row, sharp-leaved maple and birch; 2d row, ash and alder; 3d row, oak and boxthorn; 4th row, linden and ash; and so forth for 20 to 40 rows; (B) 1st row, linden and boxthorn; 2d row, ash and birch; 3d row, sharp-leaved maple and hazel bush; 4th row, ash and birch; and so forth for 20 to 40 rows.

The care of these belts requires regular planting and cutting. The cutting should not be greater than from 4 to 5 percent of the total and never in excess of planting. Even with such cautious cutting, the yearly yield from 568 acres (230 hectares) of forests at Kamenno-Stepnoe was 56,503 cubic feet (1,600 cubic meters).

The total effect of tree belts of adequate size and shape when combined with a suitable crop rotation is reflected in increased crop yields (tables 2 and 3).

Conclusions

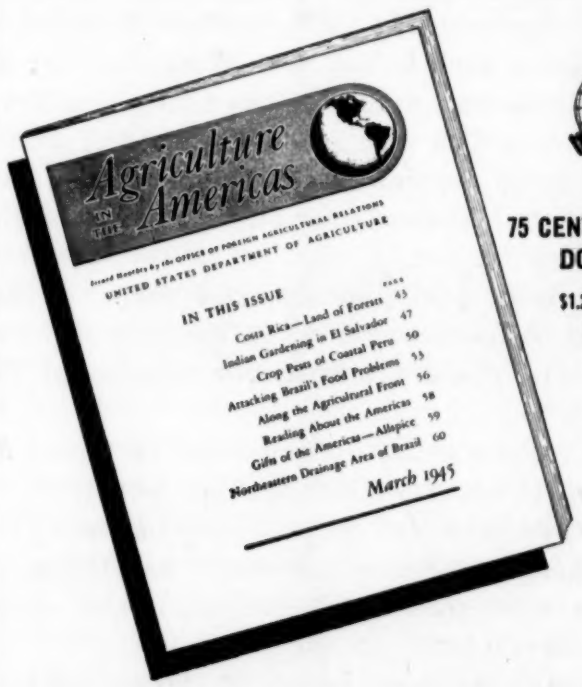
1. Quadrilateral tree shelterbelts are more effective than unilateral ones.

2. Maximum results are obtained if belts are equal to 10 percent of the enclosed area and are even wider on steep slopes.

3. The value of the afforestation is increased if crop rotations are used which include 20 percent of the area under perennial grasses, preferably a 10-crop rotation, with grass following grass.

4. The best type of trees should include from 50 to 60 percent of such trees as oak, ash, maple, and linden; 20 to 30 percent of such trees as birch, poplar, and American maple; and 30 to 10 percent of such shrubs as acacia, alder, and hazel. On steep slopes, [illegible]cept for the outer 10 rows, fruit trees and berry bus[illegible]es are best.

5. If the practices described above are followed, wind velocity is lessened, plant transpiration is reduced, snow cover and soil temperature are increased, gully formation and surface erosion can be greatly decreased, crop yields are raised. Wood is obtained for fuel, for local building, and for selling; and the food supply is increased by forest fruits, berries, and nuts.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